

CONTRIBUTION OF INTERNAL ASSEMBLIES TO WOOD-FRAME FLOOR/CEILING ASTC PERFORMANCE

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1 Introduction

In wood-frame buildings, internal walls directly mounted to the joists above (i.e., penetrating any drop ceiling) provide a flanking path for considerable potential vertical sound transmission, decreasing the Apparent Sound Transmission Class (ASTC) performance of the overall as-built assembly. With the National Building Code transition to regulating field ASTC performance from design partition STC performance, flanking paths such as these have the potential to change the acoustical performance of an otherwise well-built floor/ceiling assembly even with reasonable perimeter flanking controls at demising walls. This article presents a comparison of field measurements demonstrating the acoustical effects of flanking through internal walls mounted directly to the joists of the wood-frame floor/ceiling assembly above.

2 Background

2.1 2015 National building code of Canada

In 2015, a new National Building Code of Canada was issued, with a revised standard for evaluating the acoustical performance of a separating assembly for a dwelling unit. Prior to this change, the 2010 National Building Code had indicated that any “dwelling unit shall be separated from every other space in a building in which noise may be generated by construction providing a sound transmission class rating not less than 50.” [1] This requirement, which subsequently holds as the existing minimum STC requirement by the 2012 Ontario Building Code, applies to only the demising construction, which is tested in accordance with ASTM E-90 within a laboratory.

The 2015 National Building Code revised this requirement to specify either an STC rating of not less than 50 for the separating assembly (assessed as before) in conjunction with the adjoining assemblies, or an ASTC rating of not less than 47 for the “separating assembly and adjoining constructions” as a whole. [2] This second option offers a national standard for evaluating field measurements of a separating assembly, which intrinsically include flanking from adjacent walls and any other potential transmission paths. Since this publication, the Ministry of Municipal Affairs has issued a 2016 proposal to change the 2012 Ontario Building Code to match those of the revised national code requirements [3].

In coordination with the new ASTC requirements, the

National Research Council Canada has created “SoundPaths,” an online tool for predicting the ASTC of a separating assembly when considering flanking from the adjoining components. While the web tool is yet to be fully developed, results from the existing version of the program have been compared to field results from applicable case studies, and discussed further herein.

2.2 Wood frame internal walls

In wood frame buildings, typically up to 6 storeys, internal wood or steel stud walls often terminate at a drop ceiling (as shown in Figure 1a). This leaves a continuous air gap between the dropped ceiling (usually on isolating resilient channels) and floor joists above, which includes insulation. With this configuration, internal walls are structurally disconnected from the floor joists above, effectively reducing the number of adjoining constructions from the separating floor/ceiling assembly.



Figure 1: A (Left): studs terminate at drop ceiling, B (right): studs terminate at joists.

An alternative configuration used by architects in wood frame buildings extends internal wood or steel stud walls through any drop ceilings and up to the floor joists above. As shown in Figure 1b, the double top plate is sandwiched between the wall studs and the floor joists, creating a rigid connection between the two building elements. This detail can provide a flanking path through the internal wall studs, through the top plate, and into the floor joists, where sound from below is transmitted into the space above the floor.

The resulting total sound transmission class of the in-situ floor/ceiling assembly is evaluated by logarithmically adding the individual STC rating of the floor/ceiling construction, with each STC rating attributed to sound transmission through an adjoining wall and up to the space above. Note that the existing version of the SoundPaths online tool assumes the latter configuration (i.e., Figure 1b) for all vertically stacked wood frame building sound transmission predictions.

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3 Measurement data

3.1 Laboratory data

Published laboratory measurement data for a wood frame floor/ceiling assembly was readily available from the 2012 Ontario Building Code MMAH Supplementary Standard Table SB-3 [4]. For comparative purposes, a type F14c floor/ceiling assembly from Table SB-3 was considered, consisting of one layer of 15.5 mm plywood sheathing with a 25 mm gypsum/concrete topping, supported by wood floor joists spaced at not more than 610 mm on-centre with acoustical fiberglass batt insulation in the joist cavity (no thickness indicated), 13 mm resilient channels spaced at 400 mm on-centre, and one layer of 15.9 mm type ‘X’ gypsum board on the ceiling side. This assembly is listed to have a design rating of STC-60, with the transmission loss shown in Figure 2.

3.2 Field measurements

Measurements to test the performance of this OBC type F14c assembly were required on a recently constructed stacked townhome building to assess compliance with the Ontario Building Code requirement of STC-50. One ASTC test was conducted in a relatively small source room below the floor/ceiling test specimen, with a higher ratio of wall area to the area of the separating assembly (A_{SA}). A second ASTC test of the same floor/ceiling assembly was conducted in a larger source room, resulting in a smaller ratio of wall area to the area of the separating assembly. Wall area to floor/ceiling area ratios for these source room configurations are summarized below, and measurement results from the subsequent ASTC tests are summarized in Figure 2.

4 Discussion

4.1 Comparison of adjoining constructions

As shown in Figure 2, both field assemblies tested lower than the laboratory performance of the floor/ceiling construction above. The difference between STC and ASTC can be attributed to various flanking paths, either common or unique to each test. One flanking path that is different for each field test can be attributed to the variance in wall area between the two source rooms (detailed in Table 1). As shown in Figure 2, the floor/ceiling assembly above the smaller room (i.e. higher A_{WALL} to A_{SA}) performed four STC points lower than the floor/ceiling assembly above the larger room.

The ASTC spectral curve for each of the two tests follows a similar trend, indicating that the sound transmission paths between the two tests are similar in characteristic flanking and main separation assembly. For example, a largely unique flanking path to one test, such as a hole in the test specimen, would result in a different spectral result (i.e., different curve shape) measured above in comparison to another test without this path. Results with a similar performance spectrum and lower ASTC rating may

characterize a common flanking path which is more dominant in one test than the other.

Table 1: Variance in wall area between source rooms

	Room 1	Room 2
Internal A_{WALL} to A_{SA} Ratio	140 %	40 %
Demising A_{WALL} to A_{SA} Ratio	73 %	97 %
Total A_{WALL} to A_{SA} Ratio	213 %	137 %
Measured Floor/Ceiling STC	ASTC-49	ASTC-53

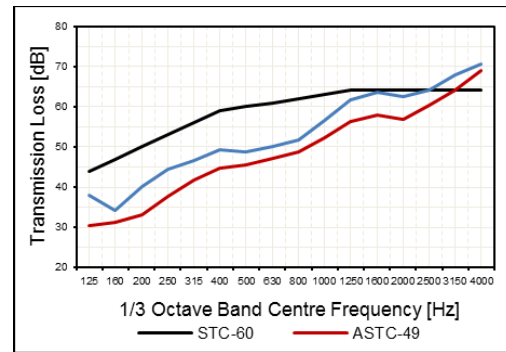


Figure 2: Transmission Loss Results

4.2 Possible mitigating assemblies

This potential flanking path may be mitigated by securing internal wall studs from below the ceiling drywall (Figure 1a), providing a structural disconnection from the floor joists above. Alternatively, wall studs which protrude through the ceiling and up to the joists can be separated from the joists using neoprene plate isolators, or the internal wall drywall can be secured to the wall studs using resilient channels; however, the latter of these alternatives is expected to be less practical. These measures have not been evaluated herein.

5 Conclusions

Preliminary results from a case study support the expected trend of lower floor/ceiling ASTC performance with higher wall area within buildings in which the internal walls are rigidly secured to the floor joists. Following steps could include sound intensity measurements to quantify sound power entering or leaving each room component, with focus on both internal walls and dwelling unit demising walls. Nevertheless, further investigation is required to develop a more detailed relationship between wall area and floor/ceiling ASTC performance.

References

- [1] National Research Council Canada. National Building Code of Canada, Volume 1. 2015.
- [2] National Research Council Canada. National Building Code of Canada, Volume 2. 2010.
- [3] Ministry of Municipal Affairs. Proposed Change to the 2012 Building Code O. Reg. 332/12 As Amended, 2016.
- [4] Ministry of Municipal Affairs. Ontario Building Code MMAH Supplementary Standard SB-3, 2012.